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[54] **ADJUNCT ACTUATOR FOR VEHICLE DOOR LOCK**

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Related U.S. Application Data

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[51] **Int. Cl.**[6] **E05B 47/00**

[52] **U.S. Cl.** **70/277**; 70/279; 74/89.18; 292/201

[58] **Field of Search** .... 70/264, 277, 279, 70/280–282, DIG. 42; 74/89.18; 292/201, 336.3, DIG. 62, 142, 199

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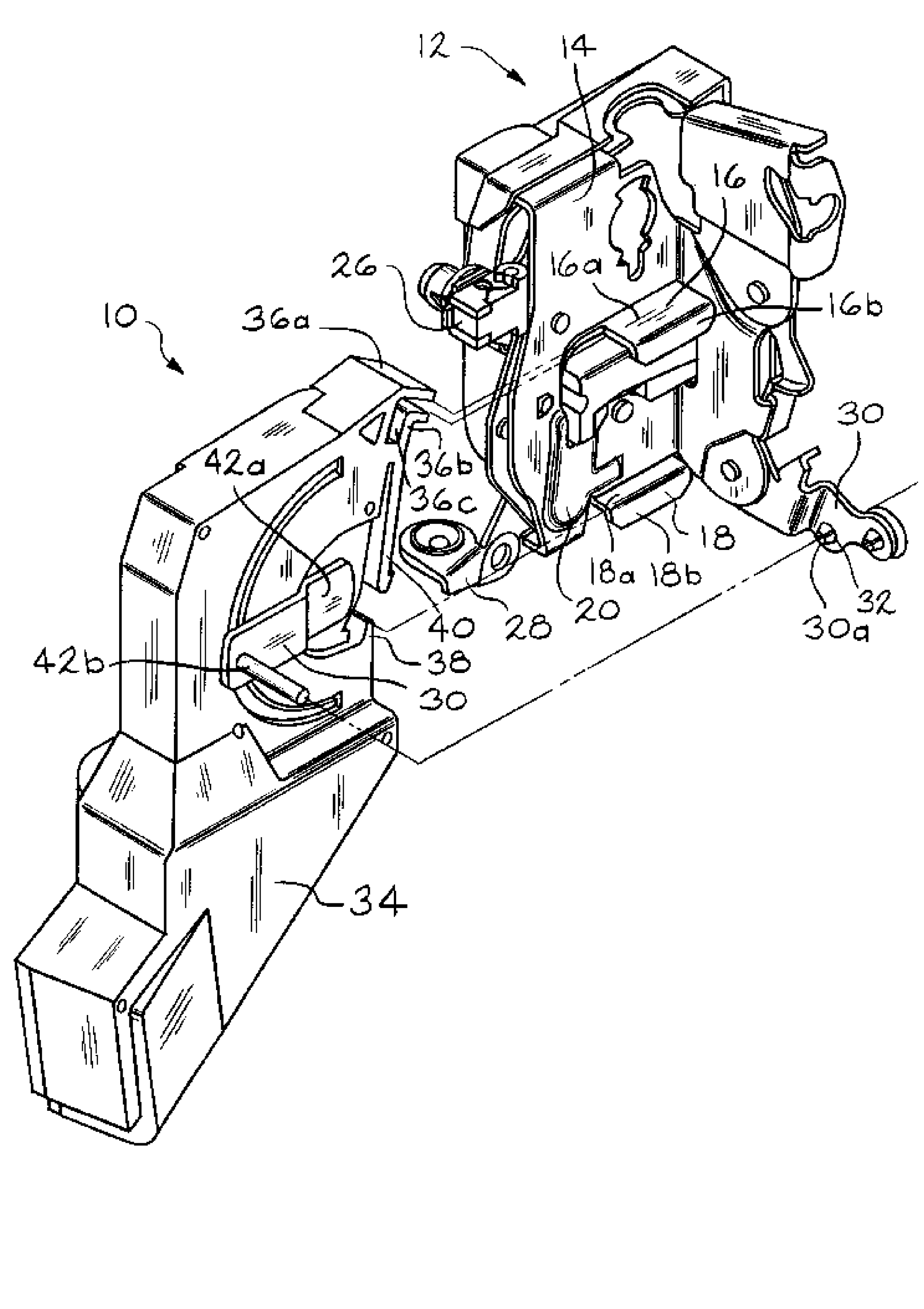
[57] **ABSTRACT**

An adjunct actuator including an electric actuator motor and associated gear train providing motive power for remotely operating an output arm of the adjunct actuator. A lost motion clutch mechanism is provided between the gear train and the output arm. The lost motion clutch mechanism includes a floating sector gear driven by the gear train. The sector gear rides upon an arcuate rail formed on the actuator frame. The sector gear is driven to a neutral position by a spring when the electric motor is deenergized. The spring of the adjunct actuator is not preloaded during assembly of the adjunct actuator. The sector gear is disposed to drive an arcuate carriage which is pivotally mounted on the actuator frame to move about a common rotational axis with the sector gear. A pair of driving faces of the sector gear are interposed between a pair of driven faces on the carriage in a manner providing lost motion between the sector gear and the carriage. The output arm of the adjunct actuator is operatively connected to the carriage for rotation therewith.

31 Claims, 3 Drawing Sheets



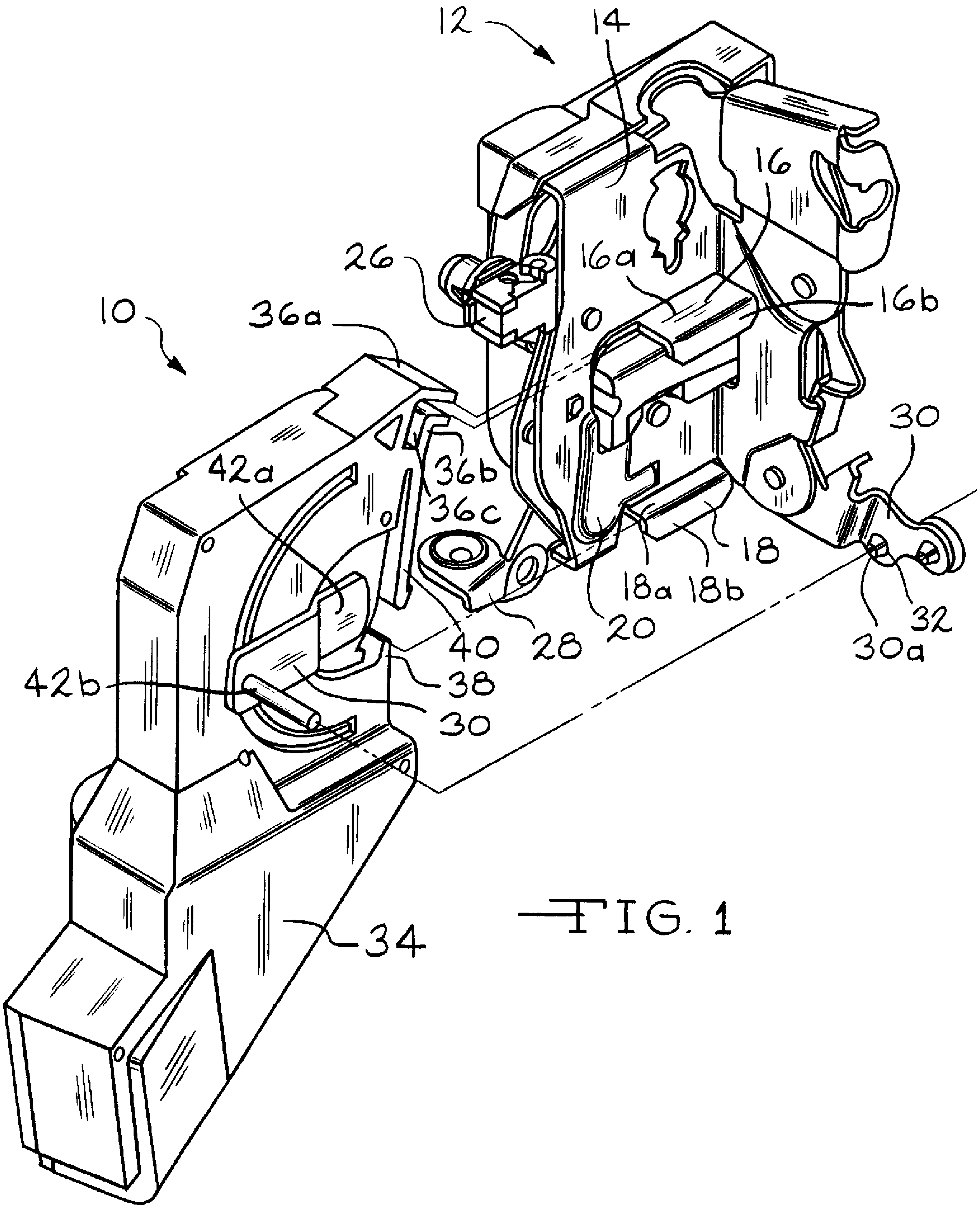

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FIG. 1

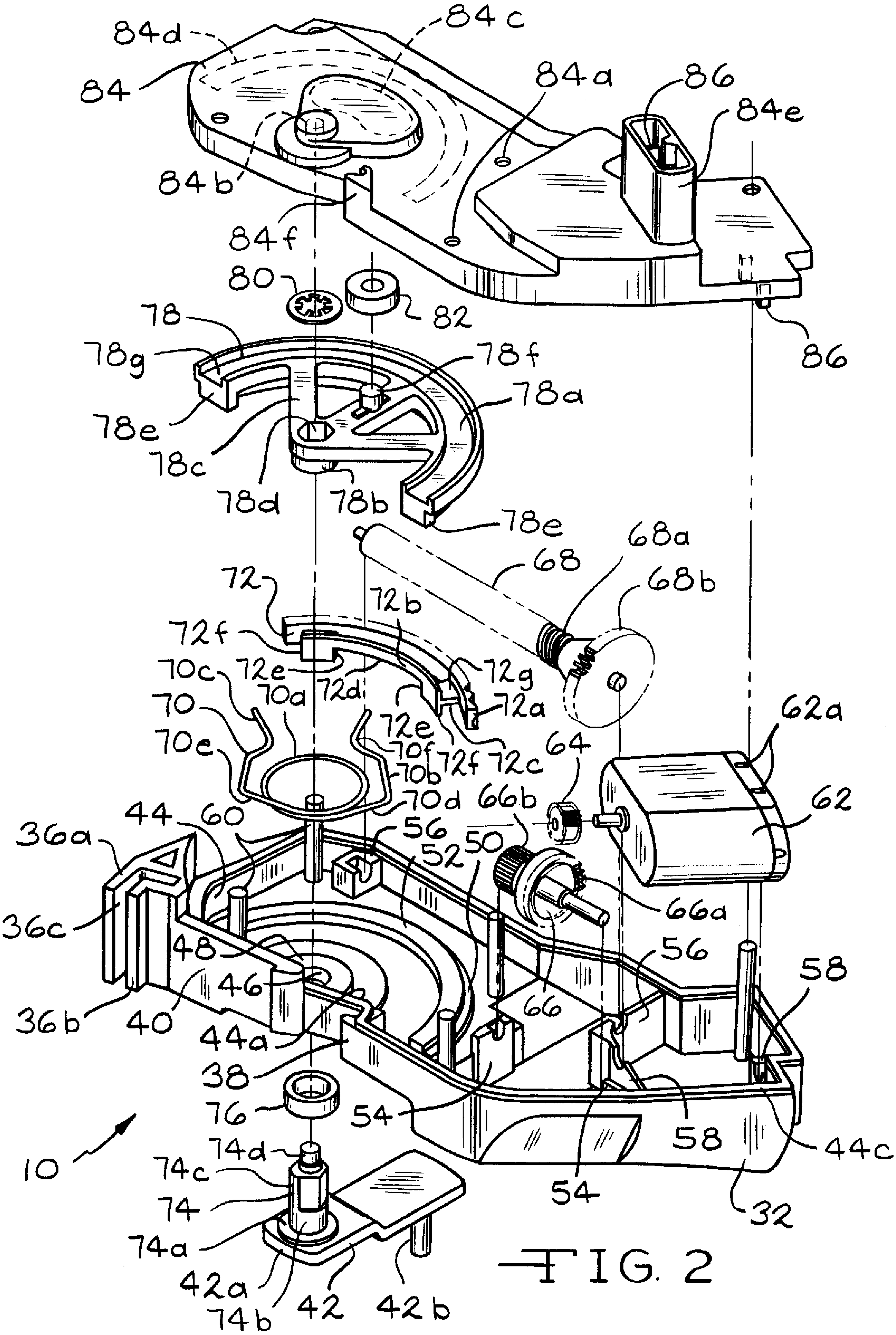
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FIG. 2

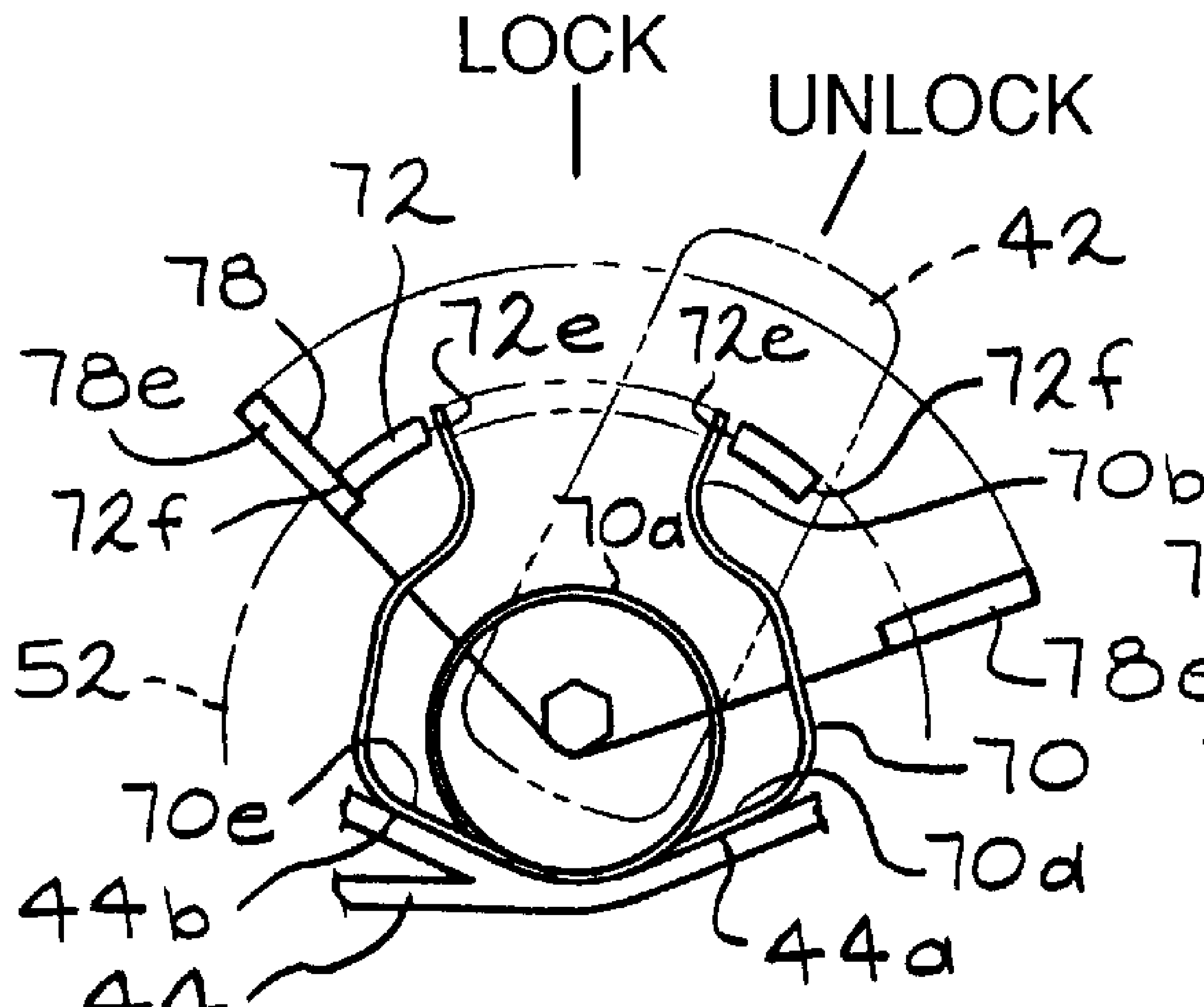

FIG. 3

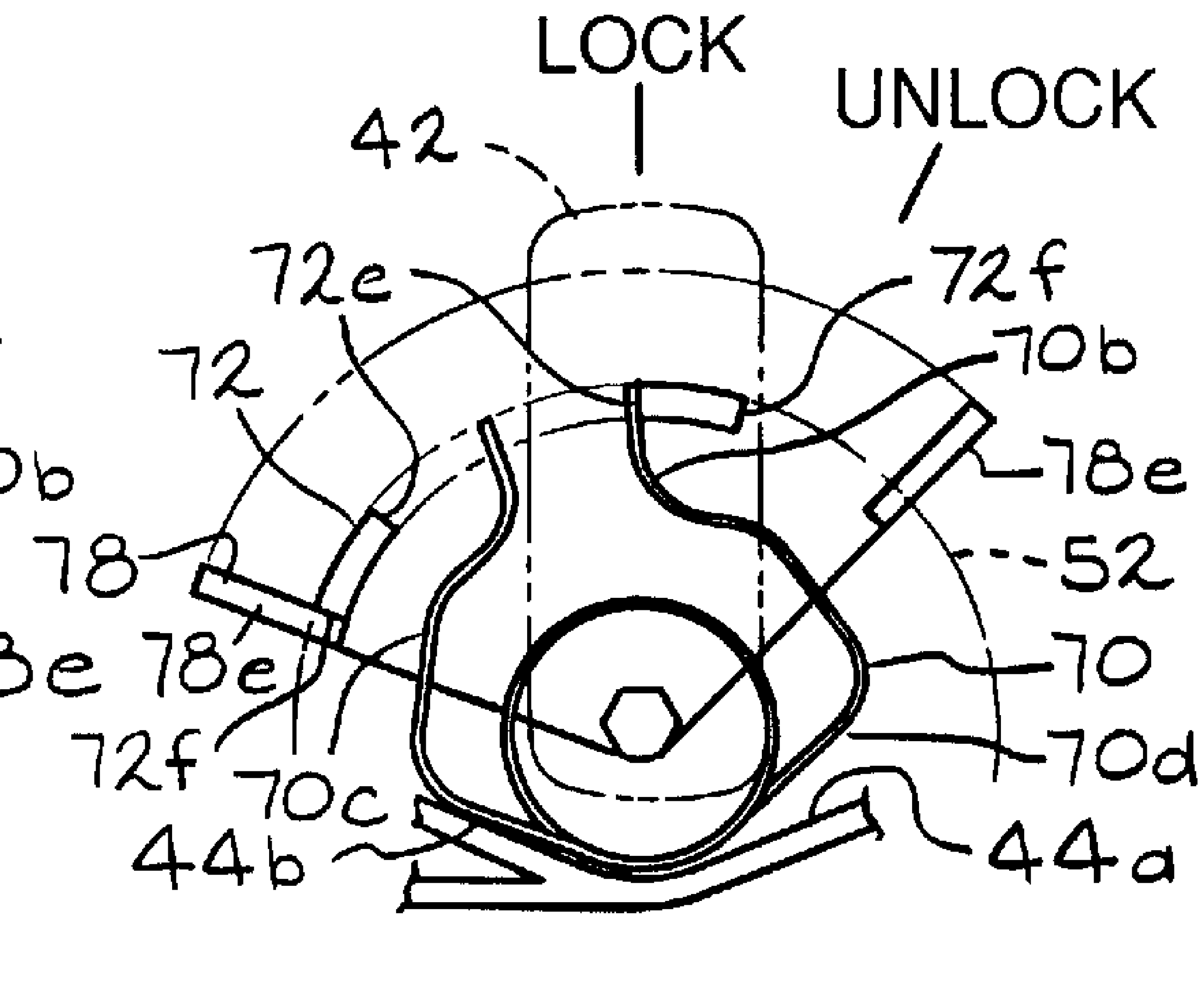

FIG. 4

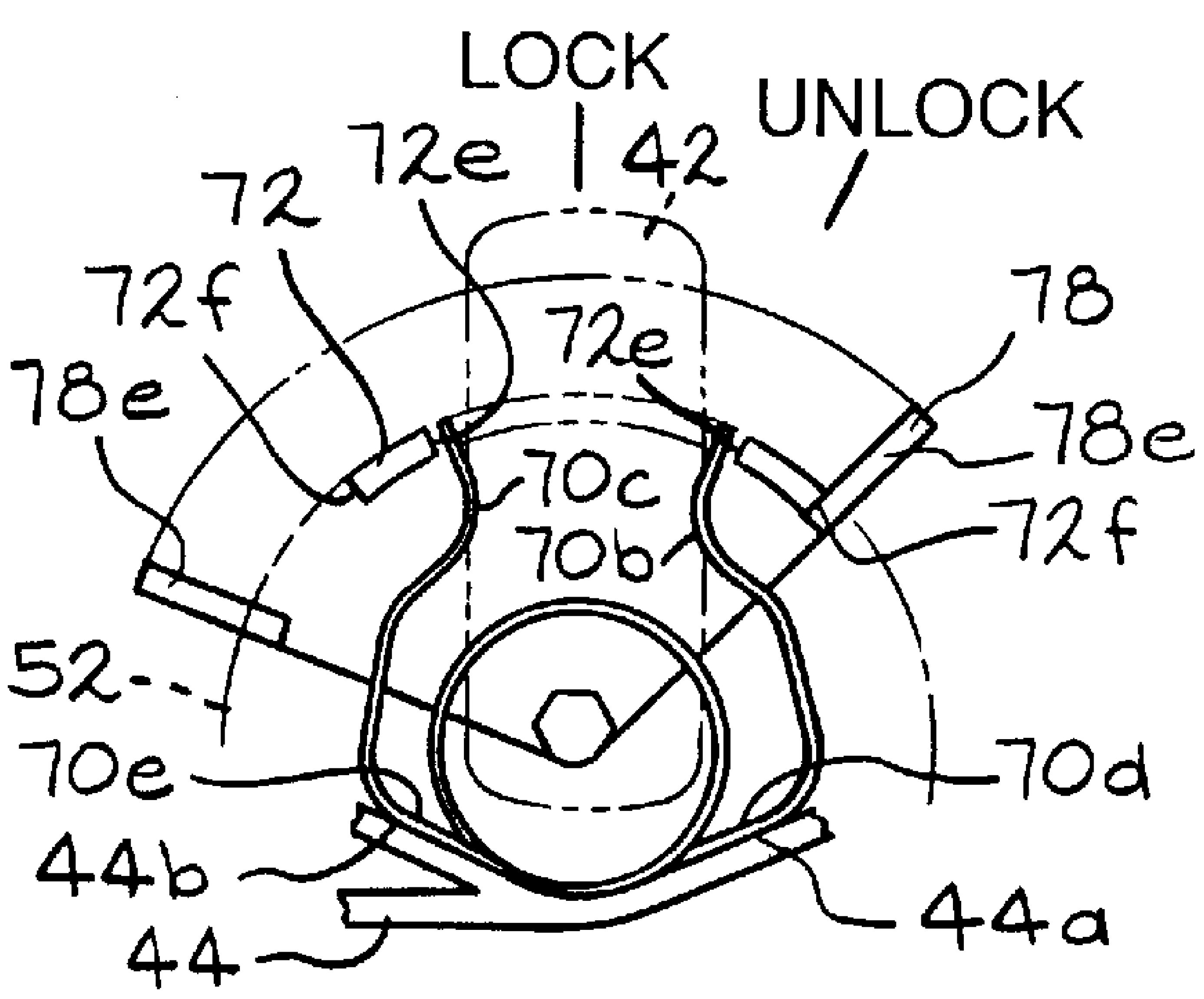

FIG. 5

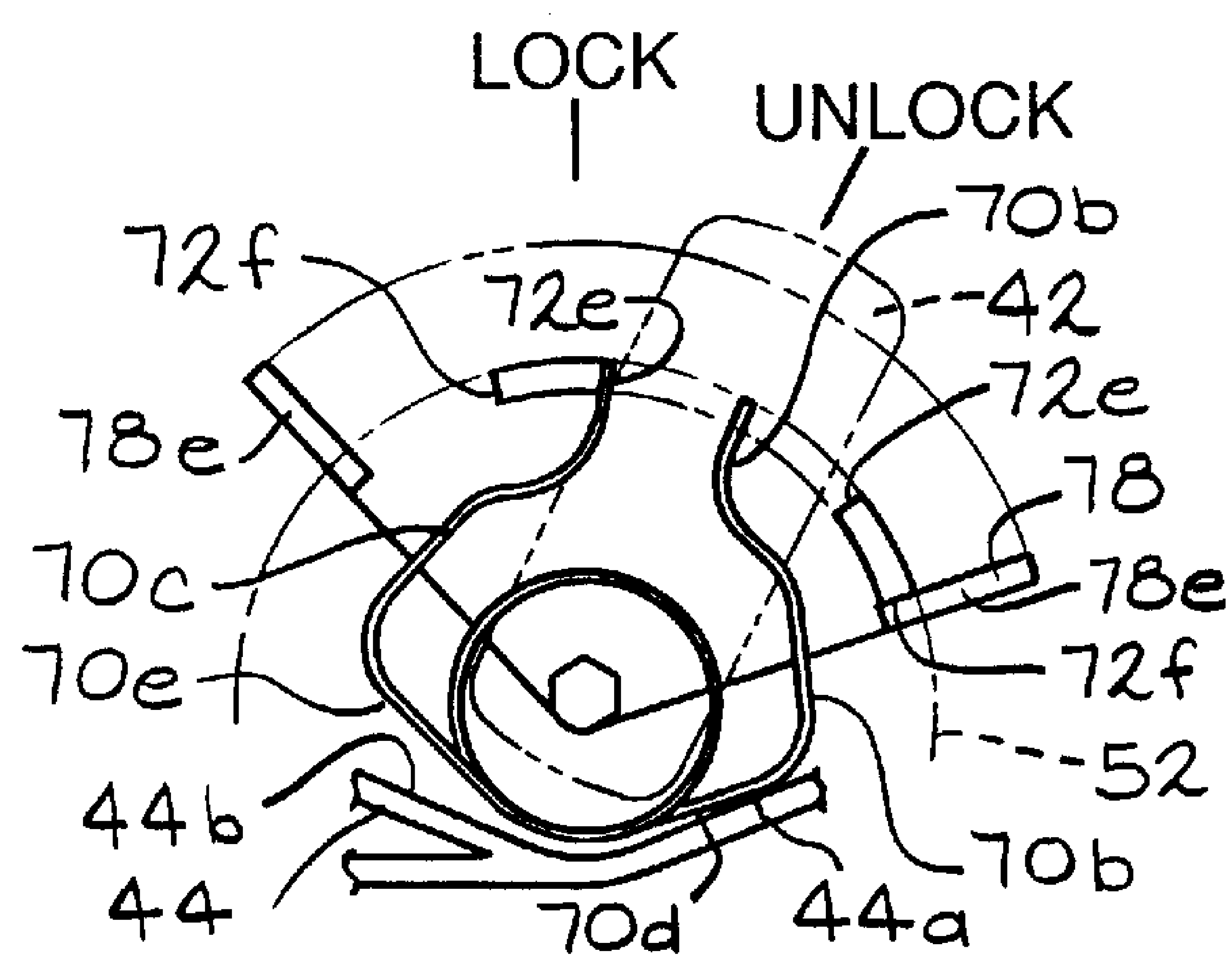

FIG. 6

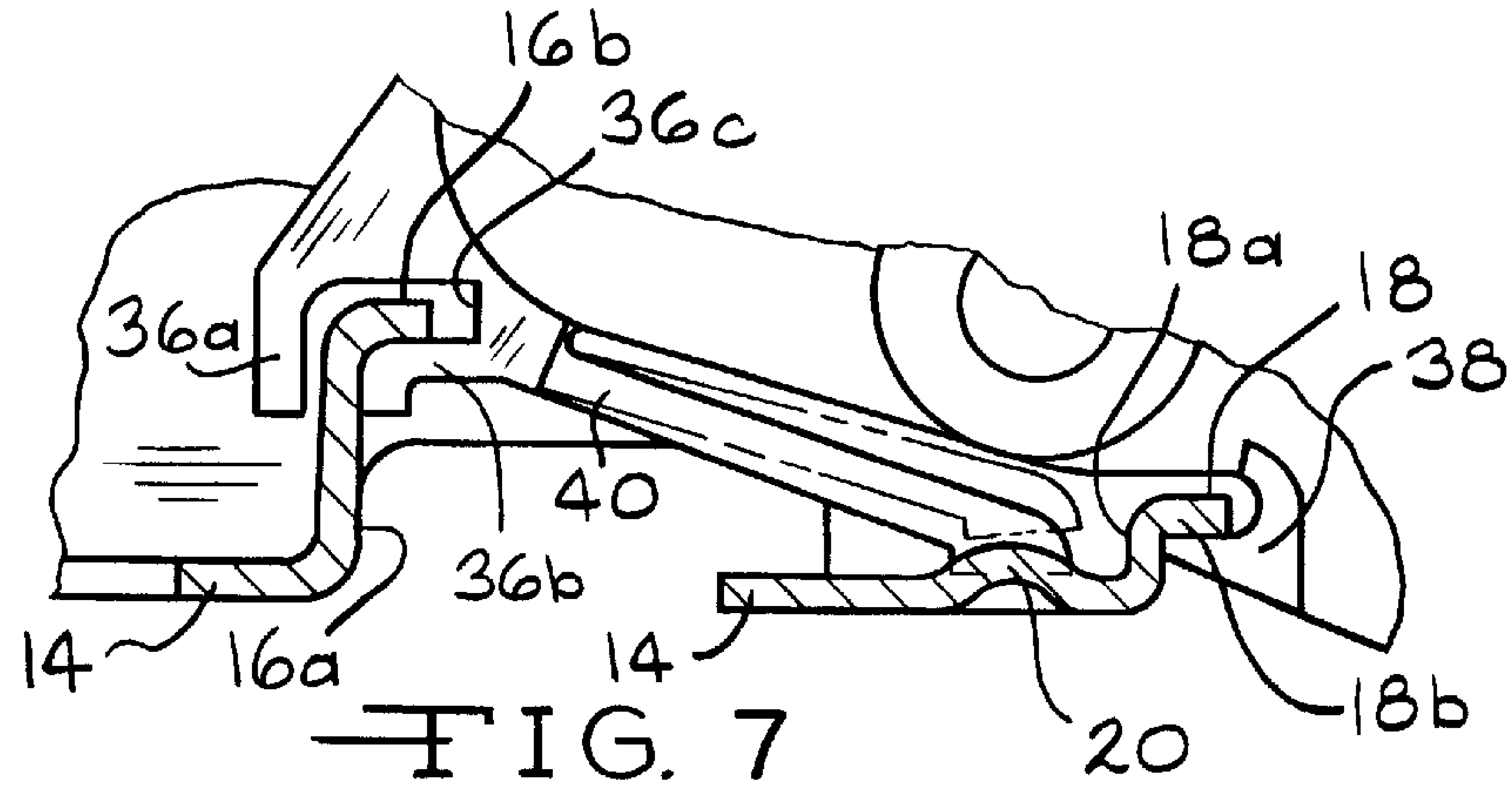

FIG. 7

ADJUNCT ACTUATOR FOR VEHICLE DOOR LOCK

CROSS-REFERENCE TO RELATED APPLICATION

This application is a divisional of pending application Ser. No. 08/500,797 filed on Jul. 11, 1995, and assigned to the assignee of this application.

BACKGROUND OF THE INVENTION

This invention relates in general to power operated locks for door latch assemblies and in particular to an improved adjunct actuator structure for vehicle door locks.

Vehicles such as passenger cars are commonly equipped with individual latch assemblies which secure respective passenger and driver doors closed. Each latch assembly is typically provided with a manual latch actuating mechanism for unlatching the latch assembly from outside and inside the vehicle, for example, respective inner and outer door handles. Each latch assembly is also typically provided with an individual lock for preventing unauthorized opening of the vehicle door. These locks are typically operatively coupled to a key-operated mechanism for manually operating the lock from the exterior of the vehicle and provided with a manual mechanism for operating the lock from the interior of the vehicle, such as a respective sill button.

Furthermore these locks are commonly provided with a respective power actuator for operating the lock. Such actuators may be controlled by the actuation of a remote device such as an electrical switch located inside the vehicle or a hand held transmitter operatively coupled to the remote operating mechanism through a vehicle security system.

It has been a common practice to mount a vehicle door latch and the associated lock on a common frame to form a latch assembly, which is then fastened to the vehicle at the appropriate location. If power operation of the lock was to be provided for in certain models of a vehicle, a power lock actuator could be provided. If the power lock actuator is mounted on a separate actuator frame, which was then fastened to the vehicle at a location remote from the latch frame upon which the latch and lock were mounted, the power actuator is referred to as a remote lock actuator. The remote lock actuator was then operatively coupled to the lock by a rod or other linkage transmitting motion from the remote lock actuator to the lock. Such a connecting rod was often quite lengthy, relatively easy to damage during use or servicing of door components, and did not always permit optimum geometry in connecting to the lock on the latch assembly. Furthermore, such connecting rods are relatively vulnerable to manipulation by thieves reaching into the interior of vehicle doors with various tools, allowing the lock to be defeated.

More recently, power door locks have become a standard feature in some vehicles. This has lead to power lock actuators being designed which are mounted on the same frame as the latch and the associated lock. These are referred to as integrated door lock actuators. Integrated door lock actuators eliminate the lengthy connecting rod between the remote lock actuator and lock, but lack flexibility in application. Such an arrangement would be unsuitable for use in situations where a single design of latch assembly is to be used in a line of vehicles in which some models would have power lock actuation capability and some are to be strictly manually operated.

The power lock actuator should not interfere with manual operation of the lock when the power lock actuator is operatively connected to the lock mechanism of the latch assembly. It is known to provide lost motion in a power lock actuator so that when the lock mechanism of the latch assembly is manually operated, for example with a door lock key, not all of the movable components of the power lock actuator have to be manually back-driven. This lost motion feature reduces the operating effort required for manual operation of the lock mechanism. In order to provide this lost motion feature for a power actuator, the power actuators of the past have typically been provided with some sort of preloaded spring, which may be difficult to assemble during manufacture of the power actuator.

SUMMARY OF THE INVENTION

This invention relates to a power lock actuator mounted on a respective actuator frame. The power lock actuator includes an electric actuator motor and associated gear train providing motive power for remotely operating an output arm of the power lock actuator. A lost motion clutch mechanism is provided between the gear train and the output arm. The lost motion clutch mechanism includes a sector gear driven by the gear train. The sector gear rides upon an arcuate rail formed on the actuator frame. The sector gear is driven to a neutral position by a spring when the electric motor is deenergized. The spring of the power lock actuator is not preloaded during assembly of the power actuator. The sector gear is disposed to drive an arcuate carriage which is pivotally mounted on the actuator frame to move about a common rotational axis with the sector gear. A pair of driving faces of the sector gear are interposed between a pair of driven faces on the carriage in a manner providing lost motion between the sector gear and the carriage. The output arm of the power actuator is operatively connected to the carriage for rotation therewith.

The actuator frame is adapted to be mounted onto a latch frame of a vehicle door latch assembly which is provided with a lock. This type of power actuator is referred to as an adjunct actuator. The latch frame is provided with a first engagement member defining an axis. The actuator frame has a second engagement member fixed thereto which is adapted to engage the first engagement member. When the first and second engagement members are mated, movement of the actuator frame relative to the latch frame is limited to movement along the axis defined by the first engagement member. The actuator frame and the latch frame may be moved relative to one another to a coupled position in which the first and second engagement members are engaged and the power actuator is operatively coupled to the lock of the latch assembly. The actuator frame and the latch frame may also be moved relative to one another to an uncoupled position, in which the first and second engagement members are disengaged and the adjunct actuator is operatively uncoupled from the lock. A fastening member, which may be a spring loaded pawl, is provided to releasably hold the actuator frame and the latch frame in the coupled position.

Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the adjunct actuator of this invention with the frame of the adjunct actuator uncoupled from the frame of an associated latch assembly.

FIG. **2** is an exploded perspective view of the adjunct actuator illustrated in FIG. **1**.

FIG. **3** is a schematic diagram of the adjunct actuator illustrated in FIG. **2** with an output arm thereof in an unlock position, and a sector gear thereof in a neutral position.

FIG. **4** is a view similar to that of FIG. **3**, except showing the output arm and sector gear of the adjunct actuator in respective lock positions.

FIG. **5** is a view similar to that of FIG. **4**, except showing the sector gear of the adjunct actuator in the neutral position thereof.

FIG. **6** is a view similar to that of FIG. **3**, except showing both the output arm and the sector gear of the adjunct actuator in the unlock position thereof.

FIG. **7** is a partial sectional view of the adjunct actuator and latch assembly illustrated in FIG. **1**, taken through the respective engagement members thereof illustrating the movement of a locking finger of the adjunct actuator.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following description of the invention, certain terminology will be used for the purpose of reference only, and are not intended to be limiting. Terms such as "upper", "lower", "above", "below", "rightward", "leftward", "clockwise", and "counterclockwise" refer to directions in the drawings to which reference is made. Terms such as "inward" and "outward" refer to directions toward and away from, respectively, the geometric center of the component described. Terms such as "radially inward" and "radially outward" refer to directions toward and away from, respectively, the rotational axis of the component described. Such terminology will include the words specifically mentioned above, derivatives thereof, and words of similar import.

Referring now to the drawings, there is illustrated in FIG. **1** an adjunct actuator of this invention, indicated generally at **10**, and a conventional latch assembly **12**, with which the adjunct actuator **10** may be used. As will be further described below, the adjunct actuator **10** is not mounted directly on the vehicle frame, separately from the latch assembly **12**. The components of the adjunct actuator **10** are also not mounted on the latch assembly **12** frame as an integral part of the latch assembly **12**. Instead the adjunct actuator **10** forms an adjunct to the latch assembly **12**, in that the components of the adjunct actuator **10** are mounted on their own frame, which in turn is mounted on the frame of the latch assembly **12**.

As indicated above, the latch assembly **12** includes a latch frame **14** upon which the components of the latch assembly **12** are mounted. The latch frame **14** includes a pair of spaced apart latch frame engagement members **16** and **18**. The latch frame engagement member **16** includes a generally centrally located elongated flange **16***a* extending outwardly from the latch frame **14**. The flange **16***a* is bent over along the length thereof to form a lip **16***b* which extends towards the latch frame engagement member **18**. Thus the latch frame engagement member **16** generally has a cross section of an inverted "L" with respect to the latch frame **14**. The latch frame engagement member **18** is also formed of an elongated flange **18***a*, having a lip **18***b* formed thereon, such that the latch frame engagement member **18** generally has a cross section of an inverted "L" with respect to the latch frame **14**. The latch frame engagement member **18** is formed adjacent one edge of the latch frame **14**. The lip **18***b* generally extends away from the latch frame engagement member **16**.

The latch frame engagement members **16** and **18** are designed to cooperate with complementary actuator frame engagement members of an anti-tamper shield (not shown) for mounting the anti-tamper shield on the latch assembly **12**. As is known, the purpose of the anti-tamper shield is to cover various components of the latch assembly **12** to prevent thieves from manipulating components thereof to unlock the door. A raised boss **20** is formed in the latch frame **14** adjacent the latch frame engagement member **16**. The boss **20** may, of course, be separately formed of a suitable material and fixed to the latch frame **14**. A spring finger (not shown) on the anti-tamper shield engages the boss **20** when the anti-tamper shield is installed on the latch frame engagement members **16** and **18** to lock the anti-tamper shield in place. The anti-tamper shield is removed by bending the spring finger to a position disengaged from the boss **20** and sliding the anti-tamper shield off the latch frame engagement members **16** and **18**.

The latch assembly **12** also includes a latch fork (not shown) for engaging and, in cooperation with the latch frame **14**, retaining a conventional latch bolt (not shown). A latch release lever **26** may be selectively operated to cause the latch fork to release the latch bolt. A first lock lever **28** may be operated between associated lock and unlock positions to respectively prevent and allow actuation of the latch release lever **26** to cause the latch fork to release the latch bolt. Similarly, a second lock lever **30** may be operated between associated lock and unlock positions to respectively prevent and allow actuation of the latch release lever **26** to cause the latch fork to release the latch bolt. The lock lever **30** is provided with an opening **30***a* therethrough, which may be used for a purpose which will be described below. As shown in FIG. **1**, the opening **30***a* will preferably be provided with a plastic insert **32** fixed therein, the purpose of which will be explained below.

The adjunct actuator **10** includes a housing or actuator frame **34** upon which are mounted various components of the adjunct actuator **10**, as will be described below. The actuator frame **34** is preferably molded of a suitable plastic material. The adjunct actuator **10** includes a pair of actuator frame engagement members **36** and **38** integrally formed in the actuator frame **34**. The actuator frame engagement members **36** and **38** are complementary to the latch frame engagement members **16** and **18** of the latch assembly **12**. The actuator frame engagement member **36** includes a pair of generally "L" shaped ribs **36***a* and **36***b* defining an "L" shaped notch **36***c* therebetween. The notch **36***c* is adapted to receive the latch frame engagement member **16** therein such that the latch frame engagement member **16** is captured between the ribs **36***a* and **36***b*, thereby preventing any movement therebetween except axial movement along the latch frame engagement member **16**. Similarly, the actuator frame engagement member **38** is formed as a rib extending generally toward the actuator frame engagement member **36**. The actuator frame engagement member **38** engages the lip **18***b* of the latch frame engagement member **18**. In cooperation with the actuator frame engagement member **36** and the latch frame engagement member **16**, the actuator frame engagement member **38** and the latch frame engagement member **18** prevent movement of the adjunct actuator **10** and the latch assembly **12** except along the latch frame engagement member **18**.

A spring finger **40** is integrally formed on the actuator frame **34**. The spring finger **40** engages the boss **20** of the latch assembly **12** when the adjunct actuator **10** is mounted on the latch frame engagement members **16** and **18** to lock the adjunct actuator **10** in place.

Referring now to FIG. **7** in addition to FIG. **1**, the adjunct actuator **10** may be mounted on the latch assembly **12** by first pressing spring finger **40** of the adjunct actuator **10** against the boss **20** of the latch assembly **12** so as to bend the spring finger **40** to a bent position as shown by the phantom line in FIG. **7**. Next, the actuator frame engagement members **36** and **38** are aligned with the latch frame engagement members **16** and **18**, respectively. Then, the adjunct actuator **10** is slid onto the latch frame engagement members **16** and **18** of the latch assembly **12**. The actuator frame engagement members **36** and **38** cooperate with the respective latch frame engagement members **16** and **18** to prevent any movement of the adjunct actuator **10** relative to the latch assembly **12** except axial movement along the latch frame engagement members **16** and **18**. When the actuator frame engagement members **36** and **38** have fully engaged the latch frame engagement members **16** and **18**, the spring finger **40** will spring return to a straight position, as shown by the solid line in FIG. **7**, capturing the spring finger **40** behind the boss **20**. The spring finger **40** and the boss **20** will cooperate to prevent movement of the adjunct actuator **10** along the frame engagement members **16** and **18**. Thus, the frame **34** of the adjunct actuator **10** is fixed to the frame **14** of the latch assembly **12**. The adjunct actuator **10** may be removed from the latch assembly **12** by bending the spring finger **40** to the position disengaged from the boss **20** shown by the phantom line in FIG. **7**. The adjunct actuator **10** can then be slid off the latch frame engagement members **16** and **18** of the latch assembly **12**.

An output arm **42** is pivotally mounted at a first end **42***a* on the actuator frame **34**. The output arm **42** may be formed of any suitable material, such as a metal like aluminum. A pin **42***b* extends perpendicularly from a second end of the output arm **42**. The pin **42***b* extends through the opening **30***a* in the lock lever **30** of the latch assembly **12** when the adjunct actuator **10** is mounted on the latch assembly **12**. As the adjunct actuator **10** is beings slid onto the latch frame engagement members **16** and **18** of the latch assembly **12**, the pin **42***b* should be aligned with the opening **30***a* to cause the pin **42***b* to pass through the plastic insert **32** in the opening **30***a*. As will be further described below, the output arm **42** may be pivoted between lock and unlock positions when thus engaging the lock lever **30** to cause the lock lever **30** to be moved respectively between positions locking and unlocking the latch assembly **12**. The plastic insert **32** prevents metal-to-metal contact between the pin **42***b* and the lock lever **30** to reduce wear of the metal parts.

Referring now to FIG. **2**, the adjunct actuator **10** is shown in an exploded view. As indicated above, the actuator frame **34** is preferably molded of a suitable plastic material. One plastic which may be used is polyethylene terephthalate (PET). As also indicated above, the actuator frame engagement members **36** and **38** and the spring finger **40** are integrally formed in the actuator frame **34**. The actuator frame **34** also includes an upstanding peripheral wall **44**. As best seen in FIGS. **3** through **6**, the peripheral wall **44** includes a first portion having an inner face **44***a* and a second portion having an inner face **44***b*. The faces **44***a* and **44***b* are formed at a slight angle to one another in the shape of a “V”, for a purpose which will be described below. Preferably, the actuator frame **34** is molded in a two-part process. The first step is to mold the actuator frame **34** structure of a suitable polymeric material. Before the actuator frame **34** has completely cured, and preferably while the actuator frame **34** is still retained in the mold cavity (not shown), a second material is molded onto the upper surface of the peripheral wall **44** of the actuator frame **34**. The second material forms a strip **44***c* of a flexible elastomeric material on the top face of the peripheral wall **44**, which serves as a permanently attached gasket as further described below. Preferably the strip **44***c* forms a continuous strip about the periphery of the actuator frame **34**. One material which has been found to be suitable for forming the strip **44***c* is sold by E. I. duPont de Nemours & Company under the tradename HYTREL. HYTREL is a blocked copolymer consisting of a hard crystalline segment of polybutylene terephthalate and a soft amorphous segment based on long chain polyether glycols. Preferably, the first and second materials forming the actuator frame **34** and the strip **44***c* are chosen such that they will bond together during curing. However, it is contemplated that the second material may be adhered to the upper surface of the peripheral wall **44** by other means, such as through the use of a suitable adhesive. Preferably the strip **44***c* will have an inverted V-shape cross section, but of course may have other suitable cross sections as desired.

An opening **46** is defined through the actuator frame **34**. The opening **46** is counterbored with a larger diameter opening lower section (not shown) and a reduced diameter upper section (visible in FIG. **2**). A raised rib **48** is formed about the opening **46** on the upper surface of the actuator frame **34**.

Formed on the upper surface of the actuator frame, in a semi-circular arc about the opening **46**, is a stepped rib forming a lower track **50** and an upper track **52**, the purpose of which will be discussed below. The rib is stepped because the radius of the outer face of the upper track **52** is less than the radius of the outer face of the lower track **50**. The purpose of the lower track **50** and the upper track **52** will be discussed below. The rib forming the tracks **50** and **52** is centered on the opening **46**, which is to say that all points along the arcuate line defined by the rib are equidistant from the center of the opening **46**.

Also integrally formed on the upper surface of the actuator frame **34** are first and second pairs of gear nests, **54** and **56**, respectively, and a pair of motor mounts **58**. Each gear nest and motor mount has a U-shaped notch defined in the upper surface thereof to receive and support components which will be described below. A plurality of upstanding pins **60** are integrally molded on the upper surface of the actuator frame **34**, the purpose of which will be described below.

A conventional electric motor **62** is mounted on the actuator frame **34**, and located on the actuator frame **34** by engagement at either end thereof with the motor mounts **58**. The motor **62** is preferably of the type having a pair of electrical sockets **62***a* provided on the upper surface thereof. A drive gear **64** is fixed to the shaft of the motor **62**.

A face gear member **66** having a face gear **66***a* formed at one end and a spur gear **66***b* formed at the other end thereof is rotatably mounted in the first pair of gear nests **54**. The face gear **66***a* meshes with the drive gear **64** on the shaft of the motor **62**. The shaft of the motor **62** preferably forms an angle of about 45 to 75 degrees to the axis of rotation of the face gear member **66**, and most preferably forms an angle of about 65 degrees thereto. It is contemplated that other suitable gear configurations, such as bevel and hypoid gears, may be used to connect the shaft of the motor **62** to the gear member **66** at the desired angle thereto.

A worm gear member **68** having an elongated worm **68***a* at one end and a spur gear **68***b* at the other end thereof is rotatably mounted in the second pair of gear nests **56**. The axis of rotation of the worm gear member **68** is preferably parallel to the axis of rotation of the face gear member **66**, and to the same side of the face gear member **66** as the motor **62** such that the axis of rotation of the worm gear member

68 may be extended through the motor. The spur gear **68***b* of the worm gear member **68** meshes with the spur gear **66***b* of the face gear member **66**. The worm gear member **68** is thus operatively connected to the electric motor **62** through the face gear member **66** in a compact arrangement. Preferably, the axes of rotation of the gear members **66** and **68** and the shaft of the motor **62** lie in a single plane.

A wire spring **70** is mounted on top of the raised rib **48** about the opening **46** in the actuator frame **34**. The spring **70** has a central looped section **70***a*, disposed about the opening **46**, and a pair of arms **70***b* and **70***c*. As best seen in FIGS. **3** and **5**, each of the arms **70***b* and **70***c* has a respective straight section, **70***d* and **70***e*, connected to the looped section **70***a*. The straight section **70***d* of the arm **70***b* lies adjacent the face **44***a* of the peripheral wall **44** of the actuator frame **34**. Similarly, the straight section **70***e* of the arm **70***c* lies adjacent the face **44***b* of the peripheral wall **44** of the actuator frame **34**. The straight sections **70***d* and **70***e* of the spring **70** form an angle which is about the same as the angle between the faces **44***a* and **44***b*, which serves to help properly orient the spring **70** on the actuator frame **34**. The arm **70***b* has an S-shaped section **70***f*, which forms an outwardly hooked end portion. The arm **70***c* is a mirror image of the arm **70***b* , and thus also has an outwardly hooked end portion. The end portions of the arms **70***b* and **70***c* extend over the upper track **52** formed on the actuator frame **34**.

An arcuate sector gear **72** is slidingly mounted on the upper track **52**, and thus moves about a rotational axis defined through the opening **46** in the actuator frame **34**. The sector gear **72** includes an arcuate outer flange **72***a* disposed adjacent the radially outer face of the upper track **52** and an arcuate inner flange **72***b* which is spaced radially inwardly from the outer flange **72***a* and disposed adjacent the radially inner face of the upper track **52**. The outer flange **72***a* and the inner flange **72***b* are interconnected by a pair of spaced apart horizontal connecting webs **72***c*. Thus, the sector gear **72** has a generally H-shaped cross section through the connecting webs **72***c*. The sector gear **72** straddles the upper track **52** to prevent radial movement (toward or away from the axis of rotation) of the sector gear **72**, while permitting the sector gear to slide along the upper track **52**. The radially outer face of the sector gear **72** is provided with gear teeth which mesh with the worm **68***a* of the worm gear member **68**. The lower edge of the inner flange **72***b* slides on the upper surface of the actuator frame **34**. The lower edge of the outer flange **72***a* rides on the upper surface of the lower track **50**, thereby vertically positioning the sector gear **72** for proper meshing with the worm **68***a*. The connecting webs **72***c* are preferably held slightly above the upper surface of the upper track **52** so as to minimize friction as the sector gear **72** slides along the upper track **52**. The sector gear **72** may be referred to as a "floating" sector gear since it does not have a pivotally mounted hub portion. Instead, the sector gear **72** "floats" upon the tracks **50** and **52**, and orbits or rotates about an axis of rotation which does not pass through the sector gear **72**. It is contemplated, however, that alternate embodiments of the invention exist in which the sector gear **72** may be provided with a hub, and may be pivotally mounted upon a pin passing through the hub thereof. It is also contemplated that in such alternate embodiments the sector gear **72** may be replaced with a circular gear rather than the arcuate sector gear **72** of the illustrated embodiment. Thus it should be understood that the term sector gear as used in this application refers to any shaped gear, unless specifically indicated otherwise.

Preferably, the sector gear **72** rotates in the plane defined by the axes of rotation of the gear members **66** and **68** and the shaft of the motor **62**, and is disposed on the same side of the axis of rotation of the worm gear member **68** as the face gear member **66**. Thus, preferably, the axis of rotation of the face gear member **66** can be extended into the path of movement of the sector gear **72**. This arrangement has been found to be surprisingly compact.

A notch **72***d* is defined in the lower portion of the inner flange **72***b* of the sector gear **72**, thus forming a pair of spaced apart vertical faces **72***e*. These faces **72***e* are disposed adjacent to respective ones of the hooked arms **70***b* and **70***c* of the spring **70**, thus capturing the arms **70***b* and **70***c* in the notch **72***d* for a purpose which will be described below. The ends of the inner flange **72***b* form a pair of drive faces **72***f*, the purpose of which will be described below. Finally the upper surface of the connecting webs **72***c* cooperate with the opposed faces of the outer flange **72***a* and inner flange **72***b* to define a guide notch **72***g* in the upper surface of the sector gear **72**.

The output arm **42** is pivotally mounted in the opening **46** in the actuator frame **34** by means of a pin **74** extending upwardly from the first end **42***a* thereof. The pin **74**, like the pin **42***b*, is preferably formed as an integral part of the output arm **42**. A seating surface **74***a* is formed about the base of the pin **74**, the purpose of which will be described below. A cylindrical section **74***b* of the pin **74** extends up through the opening **46** in the actuator frame **34**. An engagement section **74***c* of the pin **74** extends upwardly out of the opening **46**, above the raised rib **48** formed about the opening **46**. Preferably the engagement section **74***c* has an asymmetric cross section for a purpose which will be discussed below. For example, in the illustrated embodiment, the engagement section **74***c* has a hexagonal cross section, except that one of the six sides of the engagement section **74***c* is rounded rather than flat. The purpose of such an asymmetric cross section will be discussed below. The pin **74** terminates in an upper cylindrical section **74***d* which may be of somewhat reduced diameter when compared to the subjacent engagement section **74***c*.

An elastomeric seal **76** provides a leak-proof seal between the pin **74** and the interior surface of the opening **46** in the actuator frame **34**. The seal **76** is seated within the lower enlarged diameter portion of the opening **46**. The seating surface **74***a* of the pin **74** bears against the lower surface of the seal **76**, thereby retaining the seal **76** in place.

An arcuate carriage **78** is fixed to the asymmetric engagement section **74***c* of the pin **74**. The carriage includes an arcuate outer rim **78***a* connected to a central hub **78***b* by a plurality of spokes **78***c*. The lower surface of the rim **78***a* is fitted in the arcuate guide notch **72***g* defined on the top of the sector gear **72** with a sliding fit, such that the sector gear **72** and the carriage **78** can rotate relative to one another about the vertical axis defined through the opening **46** in the actuator frame **34**.

The hub **78***b* of the carriage **78** has a vertical opening **78***d* defined therethrough. The opening **78***d* preferably has an asymmetric cross section which mates with the asymmetric engagement section **74***c* of the pin **74** to prevent relative rotational movement between the carriage **78** and the output arm **42**. The matching asymmetry of the opening **78***d* and the engagement section **74***c* ensures that the carriage **78** will be properly oriented relative to the output arm **42** when the carriage **78** is assembled thereon. Thus the carriage **78** and the output arm **42** are connected for rotation with one another about the vertical axis defined through the opening **46** in the actuator frame **34**.

A respective lug **78***e* extends downwardly at each end of the arcuate outer rim **78***a* of the carriage **78**. The inner flange

72*b* of the sector gear **72** is disposed between the lugs **78***e*. With the pin **74** of the output arm **42** as a vertex, the angle subtended by the inner flange **72***b* of the sector gear **72** between the drive faces **72***f* thereof is less than the angle subtended between the opposed inner faces of the pair of lugs **78***e* formed on said carriage **78**. Thus, as will be further described below, the drive faces **72***f* of the sector gear **72** cooperate with the lugs **78***e* of the carriage **78** to provide a lost motion operative connection between the sector gear **72** and the carriage **78**.

The carriage **78** also includes a vertically extending pin **78***f* formed on the upper surface of one of the spokes **78***c*. An arcuate guide notch **78***g* is defined in the upper surface of the carriage **78**. The purpose of the pin **78***f* and the guide notch **78***g* will be described below.

A retaining ring **80** is pressed onto the upper cylindrical section **74***d* of the pin **74** on the output arm **42** to retain the carriage **78** on the pin **74**.

An elastomeric annular bumper **82** is fitted onto the pin **78***f* on the upper surface of the carriage **78**. The purpose of the bumper **82** will be explained below.

An upper cover **84** is mated to the upper surface of the peripheral wall **44** of the actuator frame **34**. The strip **44***c* of flexible material on the upper surface of the peripheral wall **44** seals against the lower surface of the upper cover **84**. A plurality of openings **84***a* are formed through the upper cover **84**, each of which receives a corresponding one of the pins **60**. During assembly, with the upper cover **84** pressed against the actuator frame **34** to compress the strip **44***c*, the upper ends of the pins **60** are enlarged to secure the cover **84** to the actuator frame **34**. The upper ends of the pins **60** may have this enlarged head formed thereon by any common method such as orbital forming, heat staking, or ultrasonic heating. Preferably, the method used results in the pins **60** sealing the openings **84***a*. In this manner, with any cracks between the actuator frame **34** and the cover **84** sealed by the strip **44***c*, and the pin **74** on the output arm **42** sealed to the actuator frame **34** by the seal **76**, the cover **84** and the actuator frame **34** cooperate to form a leak-tight enclosure which excludes dust and other contaminants from the components mounted therein. Any suitable lubricants which may be used on the components mounted therein would also be retained in such a leak-tight enclosure.

As shown in phantom line in FIG. **2**, the cover **84** defines a cylindrical cavity **84***b* in the lower surface thereof which receives the upper cylindrical section **74***d* of the pin **74** on the output arm **42** to support the pin **74** for rotation therein. The cover **84** also defines an arcuate cavity **84***c* which receives the bumper **82** therein. As the carriage **78** is pivoted with the output arm **42**, the bumper **82** engages the inner surfaces of the cavity **84***c* to limit further movement of the carriage **78**. The bumper **82** compresses when the carriage **78** drives the bumper **82** against the inner surface of the cavity **84***c*, thereby limiting the shock to the carriage **78** and other components of the adjunct actuator **10** which are in motion therewith.

A guide track **84***d* extends downwardly from the lower surface of the cover **84**, and extends in an arc about the cavity **84***b*, and thus about the axis defined by the opening **46** through the actuator frame **34**. The guide track **84***d* engages the upper guide notch **78***g* on the carriage **78** with a slip fit, such that the guide track **84***d* helps support and guide the pivoting movement of the carriage **78**. In another embodiment (not shown) the adjunct actuator **10** does not have a guide track **84***d* on the cover or an upper guide notch **78***g*. In this alternate embodiment, the carriage **78** is guided in its pivoting movement only by the pin **74** on the output arm **42** and by sliding engagement of the guide notch **72***g* on the upper surface of the sector gear **72**.

The cover **84** also defines a socket **84***e* within which are the upper ends of a pair of electrical conductors **86**. The pair of electrical conductors **86** are preferably insert molded in the cover **84** such that the lower end of each conductor **86** is aligned with a respective one of the sockets **62***a* of the electric motor **62**, and inserted into the respective socket **62***a* when the cover **84** is assembled onto the actuator frame **34**.

The cover **84** preferably defines a rib **84***f* which forms a portion of the actuator frame engagement member **38**. The rib **84***f* extends the effective length of the actuator frame engagement member **38**, and therefore increases the stability of the attachment between the latch assembly **12** and the adjunct actuator **10**. The cover **84** also is formed with a plurality of downwardly extending flanges (not shown). These depending flanges mate with the upper surfaces of the gear nests **54** and **56** and the motor mounts **58** to rotatably secure the components mounted therein in the U-shaped notches formed in the upper surfaces of the gear nests **54** and **56** and the motor mounts **58**.

Referring now to FIGS. **3** through **6**, the operation of the adjunct actuator **10** will now be explained. As shown in FIG. **3**, the output arm **42** is in the unlock position thereof, with the lock lever **30** (FIG. **1**) therefore being in the unlock position thereof. The electric motor **62** (FIG. **2**) is deenergized and the spring **70** is keeping the sector gear **72** in a neutral position. Note that the spring **70** is uncompressed when the sector gear **72** is in the neutral position. Although the arms **70***b* and **70***c* of the spring may engage the vertical faces **72***e* of the notch **72***d* in the sector gear **72**, it may be preferable to provide a spring **70** in which the arms **70***b* and **70***c* are spaced somewhat closer together to facilitate insertion of the spring **70** in the notch **72***d*, as shown in FIG. **3**. A spring **70** in which the arms **70***b* and **70***c* are spaced closer together than would allow the arms **70***b* and **70***c* to engage the vertical faces **72***e* of the notch **72***d* would thus be in an uncompressed free state when the sector gear **72** is in the neutral position, and thus would not be subject to any preload. As the term is used in this application, a spring is in an uncompressed free state when the spring is free of preload, that is, the spring is not subject to external forces tending to compress or extend the spring.

If desired, the latch assembly **12** may be locked manually by moving the lock lever **30** to the lock position thereof. This will cause the output arm **42** and the carriage **78** to move counterclockwise to their respective lock position, as shown in FIG. **5**. However the clockwise lug **78***e* on the carriage **78** stops just as the lug **78***e* reaches the clockwise drive face **72***f* of the sector gear **72**, as also shown in FIG. **5**. The movement of the carriage **78** from the unlock to the lock position thereof does not cause the sector gear **72** to move from the neutral position. Thus the effort required to manually lock the latch assembly **12** is little greater than if the adjunct actuator **10** were not attached at all, since the only components of the adjunct actuator **10** that have to move during manual operation of the latch assembly **12** are the output arm **42** and the carriage **78**. Because of the lost motion connection between the sector gear **72** and the carriage **78**, there is no back-driving of the electric motor **62** through the gear members **66** and **68** and the sector gear **72**, which would significantly increase the force required to manually lock the latch assembly **12**.

When it is desired to lock the latch assembly **12** using the adjunct actuator **10**, starting from the unlocked condition illustrated in FIG. **3**, the electric motor **62** is energized to drive the sector gear **72** counterclockwise from the neutral position illustrated in FIG. **3** to a lock position illustrated in FIG. **4**. The drive face **72***f* of the sector gear **72** drives against the counterclockwise lug **78***e* of the carriage **78**, causing the carriage **78** to be rotated counterclockwise to the lock position thereof. Simultaneously, the clockwise vertical surface **72***e* of the sector gear **72** engages the arm **70***b* of the spring **70** and urges the arm **70***b* to rotate counterclockwise. The straight section **70***e* of the spring **70** bears against the face **44***b* of the peripheral wall **44** on the actuator frame **34**, resisting counterclockwise rotation of the spring **70**. Thus the sector gear **72** compresses the spring arm **70***b* counterclockwise toward the straight section **70***e* of the spring **70**. The bumper **82** engages the counterclockwise surface of the cavity **84***c*, stopping the carriage **78** and the sector gear **72** when the carriage **78** is in the lock position and, therefore, the output arm **42** and the lock lever **30** are in the lock position. The electric motor **62** is then deenergized. The spring **70** decompresses, with the arm **70***b* thereof urging the sector gear **72** to rotate clockwise back to the neutral position thereof, as shown in FIG. **5**. Of course, as the sector gear **72** rotates back to the neutral position, it back-drives the gear members **66** and **68** and the electric motor **62**. However, the energy used for this is energy from the electric motor **62** which is stored in the spring **70**, and not manual energy supplied by the user. When the spring **70** returns the sector gear **72** to the neutral position thereof, the sector gear **72** stops just as the clockwise drive face **72***f* reaches the clockwise lug **78***e* on the carriage, and thus the spring-driven sector gear **72** does not cause the carriage **78** to move out of the lock position.

The latch assembly **12** may be manually unlocked from the position illustrated in FIG. **5** by moving the lock lever **30** to the unlock position thereof. This will cause the output arm **42** and the carriage **78** to move clockwise to their respective unlock position, as shown in FIG. **3**. However the counterclockwise lug **78***e* on the carriage **78** stops just as the lug **78***e* reaches the counterclockwise drive face **72***f* of the sector gear **72**, as also shown in FIG. **3**. The movement of the carriage **78** from the lock to the unlock position thereof does not cause the sector gear **72** to move from the neutral position.

When it is desired to unlock the latch assembly **12** using the remote unlock actuator **10**, starting from the locked condition illustrated in FIG. **5**, the electric motor **62** is energized to drive the sector gear **72** clockwise from the neutral position illustrated in FIG. **3** to the unlock position illustrated in FIG. **6**. The clockwise drive face **72***f* of the sector gear **72** drives against the clockwise lug **78***e* of the carriage **78**, causing the carriage **78** to be rotated clockwise to the unlock position thereof Simultaneously, the counterclockwise vertical surface **72***e* of the sector gear **72** engages the arm **70***c* of the spring **70** and urges the arm **70***c* to rotate clockwise. The straight section **70***d* of the spring **70** bears against the face **44***a* of the peripheral wall **44**, resisting clockwise rotation of the spring **70**. Thus the sector gear **72** compresses the spring arm **70***c* clockwise toward the straight section **70***d* of the spring **70**. The bumper **82** engages the clockwise surface of the cavity **84***c*, stopping the carriage **78** and thus the sector gear **72** when the carriage **78** is in the unlock position. The output arm **42** and the lock lever **30** are thus also moved to the unlock position. The electric motor **62** is then deenergized. The spring **70** decompresses, with the arm **70***c* thereof urging the sector gear **72** to rotate counterclockwise back to the neutral position thereof, as shown in FIG. **3**, backdriving the electric motor **62**. When the sector gear **72** is returned to the neutral position thereof, the sector gear **72** stops just as the counterclockwise drive face **72***f* reaches the counterclockwise lug **78***e* on the carriage, as shown in FIG. **3**.

The principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. An adjunct vehicle lock actuator comprising:

an electric motor;

a sector gear operatively driven by said motor and rotatable between a sector gear lock position, a sector gear unlock position, and a neutral position therebetween, said sector gear having first and second spaced-apart spring engagement faces;

a carriage engagable with said sector gear and rotatable between a carriage lock position and a carriage unlock position, said carriage connected to said sector gear by a lost motion connection permitting said carriage to move between said carriage lock and carriage unlock positions when said sector gear is in said neutral position, and requiring said carriage to be in said carriage lock position when said sector gear is in said sector gear lock position and requiring said carriage to be in said carriage unlock position when said sector gear is in said sector gear unlock position, said carriage connectable to a lock actuating arm of a vehicle door lock for rotation therewith; and

a spring having a first gear engagement surface disposed adjacent said first spring engagement face of said sector gear and a second gear engagement surface disposed adjacent said second spring engagement face of said sector gear, at least one of said first gear engagement surface and said second gear engagement surface being spaced apart from the adjacent one of said first spring engagement face and said second spring engagement face when said sector gear is in said neutral position such that said spring is in an uncompressed free state, said spring being compressed to urge said sector gear toward said neutral position when said sector gear is in said sector gear lock position or said sector gear unlock position.

2. The adjunct actuator of claim **1** wherein said carriage includes an output arm fixed to an arcuate carriage member, said output arm being connectable to a lock actuating arm of a vehicle door lock for rotation therewith.

3. An adjunct vehicle lock actuator comprising:

a frame having a pin extending perpendicularly thereto defining an axis of rotation and a member fixed to said frame and defining an arc centered on said axis of rotation;

an electric motor mounted upon said frame;

a sector gear operatively driven by said motor and rotatable between a sector gear lock position, a sector gear unlock position, and a neutral position therebetween, said sector gear being slidingly mounted upon said member and engaging an arcuate portion of said member so as to be constrained to arcuate motion by said member about said axis of rotation;

a carriage mounted on said pin and pivotal relative to said frame about said axis of rotation between a carriage lock position and a carriage unlock position, said carriage connected to said sector gear by a lost motion connection permitting said carriage to move between said carriage lock and carriage unlock positions when said sector gear is in said neutral position, and requiring said carriage to be in said carriage lock position when said sector gear is in said sector gear lock position and requiring said carriage to be in said carriage unlock position when said sector gear is in said sector gear unlock position; and

a spring operatively connected to said sector gear which urges said sector gear toward said neutral position, and drives said sector gear to said neutral position when said motor is deenergized.

4. The adjunct vehicle lock actuator defined in claim **3** wherein said carriage includes a pair of spaced apart lugs formed thereon, said lugs subtending a first angle having said axis of rotation as a vertex, and wherein said sector gear includes a pair of driving faces which are interposed between said pair of lugs, said driving faces subtending a second angle with said axis of rotation as a vertex which is less than said first angle.

5. The vehicle lock actuator defined in claim **3** wherein said sector gear includes an arcuate outer flange, an arcuate inner flange spaced radially inwardly from said outer flange with respect to said axis of rotation, and a web interconnecting said inner and outer flanges.

6. The vehicle lock actuator defined in claim **5** wherein said inner flange is disposed adjacent a radially inner face of said member and said outer flange is disposed adjacent a radially outer face of said member.

7. The vehicle lock actuator defined in claim **3** wherein said member is an arcuate rib.

8. The vehicle lock actuator defined in claim **3** wherein said member is integrally formed as a part of said frame.

9. An adjunct vehicle lock actuator comprising:

an output arm adapted to be connected to a vehicle lock and movable between a lock position in which the vehicle lock is locked and an unlock position in which the vehicle lock is unlocked;

a sector gear operatively connected to said output arm and movable on a path to move said output arm between said lock and unlock positions;

a worm gear member having a worm at a first end thereof which meshes with said sector gear and having a second gear at a second end thereof, said worm gear member being rotatable about a first axis of rotation;

a gear member having a first gear at a first end thereof and a second gear at a second end thereof which meshes with said second gear of said worm gear member, said gear member being rotatable about a second axis of rotation parallel to said first axis of rotation, said gear member being disposed on the same side of said first axis of rotation as said sector gear such that said second axis of rotation can be extended into the path of movement of said sector gear; and

a motor having a shaft defining a third axis of rotation and having a drive gear fixed thereto, said drive gear meshing with said first gear of said gear member, said third axis of rotation forming an angle with said second axis of rotation of between 45 and 75 degrees.

10. The adjunct vehicle lock actuator defined in claim **9** wherein said first axis of rotation and said second axis of rotation define a plane, said third axis of rotation lying within said plane.

11. The adjunct vehicle lock actuator defined in claim **10** wherein said third axis of rotation forms an angle with said second axis of rotation of about 65 degrees.

12. The adjunct vehicle lock actuator defined in claim **9** wherein said third axis of rotation forms an angle with said second axis of rotation of about 65 degrees.

13. The adjunct vehicle lock actuator defined in claim **9** wherein said path of movement of said sector gear lies within a plane defined by said first axis of rotation and said second axis of rotation.

14. The adjunct vehicle lock actuator defined in claim **13** wherein said third axis of rotation lies within said plane.

15. The adjunct vehicle lock actuator defined in claim **14** wherein said third axis of rotation forms an angle with said second axis of rotation of about 65 degrees.

16. The adjunct vehicle lock actuator defined in claim **9** wherein said second gear of said gear member and said second gear of said worm gear member are spur gears.

17. A vehicle lock actuator comprising:

an output arm adapted to be connected to a vehicle lock for locking and unlocking said vehicle lock;

a gear operatively connected to said output arm and movable between a lock position in which said vehicle lock is locked, an unlock position in which said vehicle lock is unlocked, and a neutral position therebetween;

a motor operatively connected to said gear for moving said gear; and

a spring positioned for moving said gear from said lock position to said neutral position and from said unlock position to said neutral position, wherein said spring is not subject to a preload when said gear is in said neutral position.

18. The vehicle lock actuator defined in claim **17** wherein said spring is positioned for urging a first surface of said gear to move said gear from said lock position to said neutral position, and said spring is positioned for urging a second surface of said gear to move said gear from said unlock position to said neutral position, wherein said spring is spaced apart from at least one of said first and second surfaces when said gear is in said neutral position.

19. The vehicle lock actuator defined in claim **18** herein said spring is positioned between said first and second surfaces.

20. The vehicle lock actuator defined in claim **17** wherein said gear is a sector gear.

21. The vehicle lock actuator defined in claim **17** wherein said actuator is an adjunct actuator.

22. A vehicle lock actuator comprising:

a motor having an output shaft;

a gear operatively connected to said output shaft;

a carriage engagable with said gear;

an output arm connected to said carriage and adapted to be connected to a vehicle lock, said output arm being movable between a lock position in which said vehicle lock is locked and an unlock position in which said vehicle lock is unlocked; and

a guide member defining an arc and engaging portions of said gear to constrain said engaged portions of said gear to motion along said arc;

wherein said carriage is engaged with said gear during operation of said vehicle lock actuator, such that operation of said vehicle lock actuator causes movement of said output shaft of said motor, said gear, said carriage, and said output arm, to move said output arm between said lock position and said unlock position;

and wherein said carriage is disengaged from said gear during manual operation of said vehicle lock, such that manual operation of said vehicle lock causes movement of said output arm and said carriage, but does not cause movement of said gear and said output shaft of said motor.

23. The vehicle lock actuator defined in claim **22** wherein said carriage is connected to said gear by a lost motion connection so that said carriage is engaged with said gear during operation of said vehicle lock actuator, and said carriage is disengaged from said gear during manual operation of said vehicle lock.

24. The vehicle lock actuator defined in claim **22** additionally comprising a gear assembly connected between said gear and said output shaft of said motor;

wherein operation of said vehicle lock actuator causes movement of said output shaft of said motor, said gear assembly, said gear, said carriage, and said output arm, to move said output arm between said lock position and said unlock position;

and wherein manual operation of said vehicle lock causes movement of said output arm and said carriage, but does not cause movement of said gear, said gear assembly, and said output shaft of said motor.

25. The vehicle lock actuator defined in claim **22** wherein said actuator is an adjunct actuator.

26. The vehicle lock actuator defined in claim **22** wherein said gear is a sector gear.

27. An adjunct vehicle lock actuator comprising:

an output arm adapted to be connected to a vehicle lock and movable between a lock position in which the vehicle lock is locked and an unlock position in which the vehicle lock is unlocked;

a sector gear operatively connected to said output arm and movable on a path to move said output arm between said lock and unlock positions;

a worm gear member having a worm at a first end thereof which meshes with said sector gear and having a second gear at a second end thereof, said worm gear member being rotatable about a first axis of rotation;

a gear member having a first gear at a first end thereof and a second gear at a second end thereof which meshes with said second gear of said worm gear member, said gear member being rotatable about a second axis of rotation parallel to said first axis of rotation, said gear member being disposed on the same side of said first axis of rotation as said sector gear such that said second axis of rotation can be extended into the path of movement of said sector gear; and

a motor having a shaft defining a third axis of rotation and having a drive gear fixed thereto, said drive gear meshing with said first gear of said gear member, said third axis of rotation forming an angle with said second axis of rotation.

28. The adjunct vehicle lock actuator defined in claim **27** wherein said third axis of rotation forms an angle with said second axis of rotation of between 45 and 75 degrees.

29. The adjunct vehicle lock actuator defined in claim **27** wherein said first axis of rotation and said second axis of rotation define a plane, said third axis of rotation intersecting said plane at a single point.

30. The adjunct vehicle lock actuator defined in claim **27** wherein said first axis of rotation and said second axis of rotation define a plane, said third axis of rotation lying outside of said plane.

31. The adjunct vehicle lock actuator defined in claim **27** wherein said first axis of rotation and said second axis of rotation define a plane, said third axis of rotation lying within said plane.

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